



National Ocean Survey Abstracts - 1977

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National Ocean Survey Abstracts - 1977

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U.S. DEPARTMENT OF COMMERCE

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PREFACE

The National Ocean Survey (NOS), a component of the National Oceanic and Atmospheric Administration (NOAA) within the U.S. Department of Commerce, provides charts and related information for the safe navigation of marine and air commerce. NOS also furnishes other Earth science data--from geodetic, hydrographic, oceanographic, geomagnetic, seismologic, gravimetric, and astronomical surveys or observations, investigations, and measurements--to protect life and property and to meet engineering, scientific, commercial, industrial, and defense needs.

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Anderson, H. C.

Cooperative charting in the National Ocean Survey. *Proceedings of the 16th Annual Canadian Hydrographic Conference*, Canadian Hydrographic Service, Mar. 1977, p. 29-33.

The early history of volunteer public participation in chart revision and the development by the National Ocean Survey of the present cooperative programs are described. Methods used by the U.S. Power Squadrons, U.S. Coast Guard Auxiliary, and National Ocean Survey in administering the programs are given, including methods of data processing, incentive awards, and training activities. Analysis and disposition of the data by the National Ocean Survey are detailed, and assessments are made of the usefulness of the present programs and their probable future developments.

Appell, G. F.

Current meter performance in a near-surface simulated environment. *Exposure*, v. 5, no. 2, p. 5-9.

In July 1976 preliminary tests were performed on a dynamic test apparatus which was designed to simulate a near-surface ocean current flow field in order to evaluate the performance of current meters. Test conditions, data collection and analysis techniques, and the results of tests on several current meters are briefly described.

Appell, G. F.

Evaluating the performance of flow measuring instrumentation. *Ocean Systems Conference Proceedings*, Plessey Environmental Systems, San Diego, Calif., Jan. 1977, p. 93-100.

National Ocean Survey's Test and Evaluation Laboratory (T&EL) has been actively evaluating the performance of current measuring systems and transducers. During the past 2 years, a capability has been developed to investigate the influences of turbulence and large scale dynamics on the performance of these systems through the use of laboratory simulation techniques. Data collection and analysis techniques have been automated through use of a Hewlett-Packard 9825A mini-computer system. T&EL's submerged jet flow facility has been improved with the addition of flow smoothing devices, a turbine flow meter monitoring system, and both dye and hydrogen bubble flow visualization capability. The development of these new capabilities and their applications in determining system performance to meet field measurement requirements are discussed. Test results obtained from electromagnetic and other current measuring systems and transducers are presented.

Appell, G. F.

Performance assessment of advanced ocean current sensors. Presented to *Oceans '77*, International Electrical and Electronics Engineers-Marine Technology Society, Los Angeles, Calif. Oct. 17-19, 1977, 13 p. (LISD)

Significant progress has recently been made toward the development of advanced ocean current measuring sensors. The new technology for measuring ocean currents has shown improved time response characteristics and high accuracy measurement in a three-dimensional flow pattern, while at the same time minimizing hydrodynamic distortions caused by the system's presence in a fluctuating flow field. The Test and Evaluation Laboratory of the National Ocean Survey, NOAA, has a continuing laboratory test program to assess the performance of newly developed marine sensors and to assist manufacturers and the marine community in the development testing of sensors which may have application for present or future NOAA measurement programs. Under this program, evaluation tests have been performed on several new electromagnetic and acoustic-type current measuring sensors. Tests conducted are concerned with the steady flow and dynamic (fluctuating velocity vector) response characteristics of the sensors in a system configuration. Evaluation test results obtained to date, problems encountered, and plans for future work, as well as the state-of-the-art in new current measuring sensor technology, including remote sensors, are discussed.

Baker, L. S.

Minimizing duplication through cooperation. Presented to the *Legislative Council for Photogrammetry Annual Meeting*, American Society of Photogrammetry, Bloomington, Minn., July 14, 1977, 13 p. (LISD)

Various geodetic projects are cited to illustrate how duplication can be overtaken through joint Federal cooperation. Among these are the Federal Geodetic Control Committee and the 8-year program on the New Adjustment of the North American Datum. Elimination of duplication has been successfully tried on the Government level, but no effort has been made to include State, counties, or municipalities. Individual contact between Federal program managers and many other positions can be minimized by the creation of a State Coordinator for Mapping and Surveying. A national land information system is proposed for efficient storage of land recordation data.

Baker, L. S.

Selected abstracts of the National Ocean Survey--cartographic and geodetic papers 1974-1976. Presented to the *XIII Pan American Consultation on Cartography*, Pan American Institute of Geography and History, Quito, Ecuador, Aug. 15-31, 1977, 34 p. (LISD)

The National Ocean Survey (NOS) of the National Oceanic and Atmospheric Administration is an engineering and scientific organization of the United States Department of Commerce. Among the many NOS missions is the responsibility for solving today's cartographic and geodetic problems. The effectiveness of our organization, in part, is measured by our ability to solve those problems, as well as to anticipate the future directions of our scientific and engineering programs. Visible indicators of these efforts are offered through published papers. Selected abstracts, in both Spanish and English, of some of the significant cartographic and geodetic reports released since the X General Assembly of the Pan American Institute of Geography and History held in Panama City, Panama, are contained in this document.

Banks, N. F., and Lenart, J. (USGS)

The topographic/bathymetric mapping program of the USGS and NOS. *Proceedings of the American Shore and Beach Preservation Association*, Oct. 1977, p. 78-82, Library of Congress Catalog #77-89048.

Topographic/bathymetric maps are being produced in a cooperative program of the U.S. Geological Survey and the National Ocean Survey. Commonly called "topo/bathy" maps, they combine the data of separate mapping efforts by showing contiguous topographic and bathymetric information on the same map sheets. The intent of the program is to satisfy the needs of managers and planners by providing a family of multi-use maps covering U.S. coastal areas and parts of the continental shelf. These products will also diminish duplicate coverage of coastal areas by two or more different maps at the same scale. A discussion of past and current program activities, the plan for program direction, and the usefulness of the combined single product are discussed.

Basileo, M. A.

Standardization and intercalibration techniques for marine monitoring. *Energy/Environment II*, Environmental Protection Agency publication # EPA-600/9-77-012, p. 457-458.

This program is directed at developing appropriate mechanisms whereby the measurement uncertainties associated with environmental data can be defined and controlled within prescribed limits. These data quality provisions applied to environmental monitoring programs result in "qualified data"--data with known error bands and a defined relation to accepted standards. The various standards under development can be categorized by area of use, i.e., laboratory, interlaboratory or transfer, and field. In each case, development is directed toward providing a product needed to define or reduce the uncertainty levels in a particular portion of the overall environmental measurement process. A laboratory standard for dissolved oxygen and laboratory methods for simulation of the dynamic environment encountered by current sensors are currently nearing completion. Techniques and transfer standards for conductivity/temperature/depth and precision pressure sensor intercalibrations are also nearing completion. Several investigations are in progress which seek to define the comparability of results obtained between different approaches to the measurement of chemical properties of marine waters. The trend has been to develop direct measurement (in-situ) systems to replace analytical laboratory methods in water analysis. The in-situ approach has several advantages; the most significant is probably cost per measurement. The accepted standards, however, are still defined in terms of analytical methods. To enjoy the benefits of in-situ monitoring without the loss of data quality, it is necessary to demonstrate the traceability of the newer methods to the existing standards. The results of such demonstration then serve as a basis for defining the quality of data obtained from the in-situ measurements in terms of recognized standards.

Berry, R. M.

Observational techniques for use with compensator leveling instruments for first-order levels. *Surveying and Mapping*, v. 37, no. 1, p. 17-23. *Proceedings of the American Congress on Surveying and Mapping*, Feb.-Mar. 1977, p. 360-368.

It has been demonstrated that compensator leveling instruments can produce first-order levels if appropriate observational techniques are used. Although the compensator is capable of controlling the attitude of the line of sight with adequate accuracy, it is subject to certain unique errors which, if not corrected, will introduce systematic errors that will produce significant discrepancies. Study of the systems of observation and of the mechanics of the compensator has revealed the nature of certain of these errors. This has resulted in the development of observational routines and the introduction of combinations of accessory equipment that substantially eliminate the effect of most of these errors. The general principles and mechanical nature of compensators are discussed, a suggested observational routine that will provide a maximum protection against systematic error is presented, and the relationship of each step in the process to the elimination of the effect of error is demonstrated.

Bossler, J. D.

New adjustments and land data system. *Proceedings of the American Congress on Surveying and Mapping*, Feb.-Mar. 1977, p. 681-687.

The New Adjustment of the North American Datum requires processing and converting about 2,500,000 observations to computer-readable form. Approximately 1,000,000 observations, accounting for 1,000,000 stations, have been completed. A brief review of the computer programs is presented and the relationship between the NAD83 and the land data system is discussed.

Bossler, J. D.

The requirements for the National Geodetic Survey 1978-1988. Presented to the *NASA Workshop on the Application of Space Techniques to Geodynamics*, University of Colorado, Boulder, July 18-23, 1977. (LISD)

The history of geodesy in the United States is briefly traced from its origin in 1807. Predictions are advanced for geodetic requirements of the National Ocean Survey's National Geodetic Survey in the next decade. These predicted requirements are for horizontal and vertical control, geodetic astronomy, and gravity data.

Brown, L. R. (Cornell U.), Reilinger (Cornell U.), Holdahl, S. R., and Balazs, E. I.

Post-seismic crustal uplift near Anchorage, Alaska. *Journal of Geophysical Research*, v. 82, no. 23, p. 3369-3378.

Results of four leveling systems carried out by the National Ocean Survey's National Geodetic Survey between Anchorage and Whittier, Alaska, combined with an analysis of sea level measurements at Anchorage, indicate as much as 0.55 m of land uplift in the decade following the 1964 Prince William Sound earthquake. The pattern of uplift is parabolic in shape, convex upward, and reaches a maximum approximately halfway between Anchorage and Whittier, or about 30 km northwest of the Aleutian Trench axis. The data suggest that the position of maximum uplift is migrating away from Anchorage, i.e., toward the Aleutian trench. The observed uplift occurs in a region which subsided as much as 1.9 m during the earthquake. The rate of uplift has decreased exponentially since the time of the 1964 earthquake. These movements appear to represent postseismic deformation associated with the 1964 Alaska earthquake. The observations are most easily explained by creep along the downdip extension of the fault which ruptured during the 1964 earthquake, although viscoelastic rebound and long-term elastic strain accumulation mechanisms may play a part. There is no evidence supporting magma intrusion or dilatancy mechanisms. These results provide new constraints for models of tectonic processes at convergent plate margins.

Carter, W. E., and Strange, W. E.

The National Geodetic Survey project "Polaris." Presented to the *International Association of Geodesy International Symposium on Recent Crustal Movements*, Palo Alto, Calif., July 25-30, 1977, 12 p. (LISD)

The National Geodetic Survey (NGS) of the National Ocean Survey has undertaken a new project called POLar-motion Analysis by Radio Interferometric Surveying (POLARIS). The premier goal of the project is to establish a fully operational polar motion monitoring network, with an accuracy of 10 cm or better, by the early 1980's. The new network will utilize radio interferometric techniques (VLBI) which will not only offer increased accuracy but also, because of the nearly all weather capabilities of the method, improved temporal distribution and continuity of determinations. In addition to the primary function of polar motion monitoring, the fixed observatories will also serve as base stations to be used in conjunction with small aperture, 3 to 10 meter, mobile units for positional surveys for geodetic and geodynamic applications. The NGS plans to cooperate fully with other governmental organizations having related responsibilities and interest in polar motion, earth rotation, and geodynamics (e.g., NASA, USGS, USNO, NSF) as well as academic and private researchers.

Cohen, P.M.

Ocean dumping: research and monitoring of ocean disposal effects. *Oceans '77 Conference Proceedings*, International Electrical and Electronics Engineers-Marine Technology Society, Oct. 1977, v. 2, p. 23B1-4.

A relatively new program at the National Ocean Survey, a component of the National Oceanic and Atmospheric Administration, in the research and monitoring of ocean waste disposal effects is discussed. The background leading to the structuring of this program is described, and an overview of what waste materials are deposited in ocean areas and where those areas are located is presented. Certain basic issues of ocean disposal are commented on, and studies in one specific area are described in some detail.

Collins, J., and Baxter, F. S. (USGS)

Coastal mapping programs and technical assistance available through the USGS and NOS. *Proceedings of the American Shore and Beach Preservation Association*, Jan. 1977, p. 54-61.

U.S. Geological Survey (USGS) and National Ocean Survey (NOS) programs and products to assist coastal area planners are discussed. USGS publishes several series of topographical maps in the coastal area as part of its National Mapping Program. Emphasis is given to the 7.5-minute topo series because, besides being the primary series, it also is used to update and produce other products. Products in this series in urban and coastal areas will normally be reviewed for revision on a 5-year cycle. NOS has a rather complete cartographic coastal zone data base dating from the mid-1800's. Examples of historic as well as contemporary cartographic products are shown, and some of their engineering and legal uses are explained. Types and sources of other data in the coastal zone are also presented.

Douglas, B. C., and Goad, C. C.

The role of orbit determination in satellite altimeter data analysis. *Boundary-Layer Meteorology*, no. 13, p. 151-157.

The satellite-borne radar altimeters on GEOS 3 and SEASAT produce high-precision measurement of distance from the satellite to the ocean surface. However, the precision of the GEOS 3 altimeter (50 cm) and especially the forthcoming SEASAT (10 cm) instrument far exceeds our ability to determine the position of either satellite using conventional electronic or laser tracking methods. Thus special techniques are required to prevent the uncertainty of the satellite position from degrading the value of the altimeter data. The altimeter data themselves provide a solution to this problem. Using the condition that intersections of passes of altimeter data must measure the same time-invariant part of the sea-surface height, the root-mean-square error of 292 intersections of 47 passes of GEOS 3 altimeter data from the Atlantic Ocean was reduced from 17 m to 44 cm. Simulations of the SEASAT problem also show that altimeter data can aid in determining the satellite orbit, and have their greatest value when radar or laser tracking is sparse.

Doyle, F. J. (USGS), Elassal, A. A. (USGS), and Lucas, J. R.

Selenocentric geodetic reference system. *NOAA Technical Report NOS 70 NGS 5*, Feb. 1977, 53 p. PB266046

This document is the final technical report for contract T-1168B for NASA LBJ Space Center, Houston. A reference system was established by simultaneous adjustment of 1,244 metric-camera photographs of the lunar surface (obtained from Apollo missions) from which 2,662 terrain points were positioned.

Dracup, J. F.

Doppler satellite positioning: application to geodetic control networks.
Proceedings of the 8th United Nations Regional Cartographic Conference for Asia and the Pacific, Jan. 1977.

The United States has in progress a planned network of about 150 stations in the conterminous United States whose positions will be determined from satellite Doppler data. These stations are spaced at intervals of 150-300 km and will be used in the new adjustment of the North American Datum to provide additional scale and orientation control. In addition, it is very likely these positions will be used to fit this vast network to a world reference system. A multi-adjustment test of a large network in Mississippi, Louisiana, and Alabama has been completed. Five Doppler positions were available for control. This is a report of the results obtained from four adjustments. The first, considered the base adjustment, was carried out in a conventional fashion, holding one point fixed and including all first- and second-order networks, segments of the High Precision Traverse, and numerous measured lengths and astronomic azimuths. This computation was then followed by three adjustments of the first-order nets scaled and oriented by the Doppler positions, which were introduced as weighted observations in various combinations. To compare the results obtained in the adjustments, sufficient relative accuracy estimates were computed between points common to each computation. The conclusions drawn from these accuracy estimates increase the confidence in Doppler positioning which was gained from prior experience and indicate that a network of Doppler positions could be used to control geodetic networks encompassing an entire country.

Dracup, J. F.

A further test of satellite Doppler positions to control regional networks. Presented to the *American Congress on Surveying and Mapping-American Society of Photogrammetry Annual Meeting*, Washington, D.C., Feb. 27-Mar. 3, 1977, 6 p. (LISD)

The National Geodetic Survey has been carrying out various types of evaluations related to the use of satellite Doppler positions. Some have been directed to strengthening conventional networks, others to examine the possibilities of crustal motion, one to reposition an entire land mass to accommodate new hydrographic surveys; most explored the extent these positions could be employed as fundamental control. Several new adjustments of one of these projects have been made expressly to continue the evaluation of Doppler positions as basic control. These computations do not show any remarkable new developments in this regard, but the variety of configurations of the satellite Doppler positions used provide interesting patterns with respect to the accuracies obtained. Although it was concluded from one test that a properly scaled and oriented triangulation network can be little improved by Doppler positions spaced at close intervals, the rigidity concept was based on that single examination. Additional evidence is developed that the original conclusion is probably correct. Based on the data determined from adjustments of two rather diverse networks, it is shown with considerable clarity, in a very practical way, that the strength of figure formula for triangulation and the spacing requirements for astronomic azimuths set forth many decades ago indeed assure a well-defined network.

Dracup, J. F.

The National Geodetic Survey data bank. Presented to *Utah's 13th Conference on Surveying and Mapping*, American Congress on Surveying and Mapping (Utah Section) and American Society of Photogrammetry (Utah Chapter), Salt Lake City, Utah, Nov. 15-17, 1977, 6 p. (LISD)

The National Ocean Survey's National Geodetic Survey (NGS) data base is user-oriented and, with the associated management system, is the heart of the new adjustment of the North American Datum. Without certain data base features and an advanced generation of computers, the new adjustment would not be practical. Eventually, it is hoped that all control survey data from every available source in the United States will be included. It is not expected that this will occur prior to 1985, although there are numerous States, counties, and cities contributing now. To have one massive National data bank for storage and issuance of control survey information may seem to some to be an impossible dream. But the economic realities of continued increases in surveying costs makes the development of such a system mandatory. It is believed that the NGS concept of a modular design, consisting of three major subsystems, where each logically independent function is performed by separate software, will meet present and future needs. For the moment, the data base contains about 160,000 geographic positions and associated data, including their quad identifiers, respective plane coordinate codes, and the astronomic data file. Preparations are being made to enter the station descriptions as the information is keyed and verified. Once the geographic positions and descriptions for all stations are stored in the bank, the published data sheets will be totally computer-generated. Shortly, as blocks of horizontal observations begin to pass through a validation process, these data will also be entered. With the completion of the data validation, the data base will contain the basic information necessary to carry out the new adjustment. In due course, most, if not all, data associated with the National networks of geodetic control will be contained in the data base system.

Dracup, J. F.

The new adjustment of the North American horizontal datum--state plane coordinate systems. *American Congress on Surveying and Mapping Bulletin*, v. 59, p. 27-28.

This is the ninth in a series of articles in the *ACSM Bulletin* on the new adjustment of the North American Datum (NAD). The purpose of the series is to inform the surveying community of the progress and problems associated with the massive task of the new adjustment. The single most important end product of the New Adjustment of the NAD is probably the State Plane Coordinate System (SPCS) or systems that have been adopted as the National grid. Their use will continue to be favored over geodetic positions. The policy of the National Ocean Survey and its Office of National Geodetic Survey in adopting these systems is stated. The SPCS, with certain modifications, and the Universal Transverse Mercator grids will be used on an equal basis after the completion of the NAD83.

Dracup, J. F.

New adjustment status. *Proceedings of Commission 5 (Survey Instruments and Methods) of the Federation Internationale des Geometres*, June 1977.

The status of the new adjustment of the North American horizontal datum, which includes the geodetic networks of Canada, the Central American Republics, Greenland, Mexico, and the United States, is reported. The third year of gathering, processing and evaluating the observational data is drawing to a close. The schedule, or milestones, set forth initially by the National Ocean Survey's National Geodetic Survey (NGS) has been met, with minor exceptions. The same is true for the development of the automated data base. At the same time, innovative software has led to more efficient processing as the need for human intervention is reduced. The 22,000-km, high precision Transcontinental Traverse was completed in November 1976. Only a few of the satellite Doppler positions required for the new adjustment remain to be observed. A carefully planned program to strengthen the present network with new surveys at strategic locations, and the observation of base lines and astronomic azimuths and positions at selected sites, is in progress.

Dracup, J. F.

A progress report on the new adjustment of the North American Datum. Presented to *Utah's 13th Conference on Surveying and Mapping*, American Congress on Surveying and Mapping (Utah Section) and American Society of Photogrammetry (Utah Chapter), Salt Lake City, Utah, Nov. 15-17, 1977, 9 p. (LISD)

The preparation of data for the new adjustment of the North American Datum is proceeding on schedule. Assuming that present progress continues, the final results will be published in 1983. Included in the North American Datum are the geodetic networks of the Central American Republics, Mexico, Canada, Greenland, and the United States, totalling about 250,000 stations and involving as many as 3,000,000 observations. Obviously, to merge this enormous amount of data in a simultaneous solution requires that a major effort be expended by each nation. Very harmonious relations between all participants are being maintained with frequent communications to discuss mutual problems and progress of work. There are about 225,000 stations of first-, second-, and third-order accuracy in the United States network. As of November 1977, the observational data at about 120,000 stations have been placed in machine-readable form and preliminary evaluations completed. The combining of individual projects into blocks containing about 1,000 stations each is in the beginning stages. These large systems are identified as Helmert blocks. As each block is processed, the reduced data for common stations are passed into higher level blocks, then, where necessary, into still higher level blocks until the adjustment process is completed. The development of the computer software required to meet the demands of the new adjustment is keeping pace, as are all other tasks associated with this massive project.

Dracup, J. F.

Understanding the state plane coordinate system. Presented to the *New York State Association of Professional Land Surveyors 18th Annual Conference*, Ellenville, N.Y., Jan. 18-21, 1977, 31 p. (LISD)

In the more than 40 years since the development of the state plane coordinate systems, 35 States have passed legislation permitting their use in defining property boundaries and for other purposes; but many surveyors still do not utilize the systems. During this period several publications have been issued and numerous papers have been presented which describe the value of the state grids and provide, often in great detail, instructions on how to employ the systems including the computations involved. Although recently more surveyors have shown an increasing interest in state plane coordinates, their numbers are still small. The major reasons offered for not using the systems relate primarily to several misconceptions about the state grids, and in particular to a lack of understanding of two corrections to distance measurements. These corrections involve the reduction to the sea level reference and for the scale distortions which result from confining a portion of the Earth's surface within the mathematically defined dimensions of the map projections used in the state systems. Although both corrections are arithmetical in nature and can be combined or even ignored in numerous cases, these arguments are often lost because of long-held preconceived concepts. In an attempt to overcome the reluctance of many in the profession to employ the state systems, the principal effort is directed to explaining these corrections. By using simple terminology and graphic demonstrations, the intent is to show that these reductions are far easier to understand than most believe. As a new generation of surveyors are about to assume their place in their chosen profession, this approach will hopefully lay aside many fears held previously.

Dracup, J. F., and Fronczek, C. J.

An immediate solution to the optimization problem. *Proceedings of the International Symposium on Optimization of Design and Computation of Control Networks*, International Association of Geodesy, July 1977.

Optimization of geodetic networks has been a practical reality for a quarter century. However, few in the geodetic community took advantage of this reality to plan networks. Although there has been considerable theoretical advances, these studies have been primarily mathematical in nature and relate in a practical sense only minutely to the problems encountered in the preparation of specifications, plans, and general development of geodetic nets. The general implementation of this concept might have been delayed further without the interest and impetus of the theorists. For the present, the National Ocean Survey's National Geodetic Survey has chosen to utilize simulations in planning horizontal control networks. Two examples are discussed. Given the classic least squares setup by variation of parameters, the normal equations are: $(A'PA)X = A'PL$, where A is a coefficient matrix, P a matrix of a priori estimates of the weights of the observables, X a vector of corrections to assumed unknown parameters, and L is a vector of differences. The definition of A is a declaration of the *geometry* of the network, and variations of A to

meet certain requirements are sometimes referred to as First-Order Design problems. Variations of P, likewise, are referred to as Second-Order Design problems. When A and P are allowed to vary, we have a Third-Order Design. Two examples, a practical solution to a Second-Order Design and a Third-Order Design, are presented. The first involves a special purpose project where the principal interest is in the length component accuracy in positioning a number of points relative to the center of a system. The second is concerned with developing first-order area coverage in which the use of portable towers and masts, nonclassical configurations, and the employment of triangulation, traverse, and trilateration methods in any combination are emphasized. Both are real projects in various stages of development.

Dracup, J. F., Fronczek, C. J., and Tomlinson, R. W.

Establishment of calibration base lines. *NOAA Technical Memorandum NOS NGS 8*, Aug. 1977, 22 p. PB277130

The calibration of electronic distance measuring instruments involves the determination or verification of instrument constants and the assurance that the measured distances meet accuracy specifications. Although it is not necessary to utilize a measured distance to determine or verify instrument constants, the verification effort is reduced when an accurately measured distance can be used. However, to assure that an instrument is measuring properly, a known distance of high accuracy or, preferably, a sequence of distances forming a calibration range or base line is required. Experience shows that a base line consisting of four on-line monuments spaced at intervals of 150 m, 400-430 m, and 1,000-1,400 m will meet the needs of the users. Specifications and recommendations on the establishment of calibration base lines are described in some detail.

Earle, M. D.

The application of NOAA's coastal wave monitoring program to coastal erosion. *Proceedings of the American Shore and Beach Preservation Association*, Oct. 1977, p. 170-190, Library of Congress Catalog #77-89048.

Available coastal wave data consist primarily of visual estimates of wave conditions, short-term scientific measurements, and some long-term measurements from piers and offshore platforms. Few of the available measurements provide wave energy frequency spectra, and none provide long-term wave energy directional spectra. Studies of coastal processes and the prevention of coastal erosion urgently require better knowledge of coastal wave conditions. In addition to improving scientific understanding of coastal processes long-term wave data and wave statistics will result in significant economic benefits when applied to coastal erosion projects and studies. To provide the needed wave data and wave statistics, the National Ocean Survey, NOAA, has begun the Coastal Wave Monitoring Program which will collect and analyze long-term coastal and offshore wave spectral data at many locations.

Earle, M. D.

Practical determination of design wave conditions. Presented to the *National Ocean Survey Ocean Wave Climate Symposium*, Herndon, Va., July 12-14, 1977. Proceedings: *Marine Sciences Series*, v. 8, Plenum Press.

Wave models which can be used to determine design wave conditions for coastal and offshore structures are reviewed. Comparisons are made between model results and wave measurements, and between results from different models. Overall, the accuracy of the wave models is approximately 1-2 meters but, due to a lack of measured wave data, even this number is an estimate. There is a need to evaluate directional spectra models by comparison with measured wave energy directional spectra.

Flier, A. N.

The computer generated waypoint grid: RNAV control for airborne surveys. *Navigation: Journal of the Institute of Navigation*, v. 24, no. 2, p. 132-141.

The National Ocean Survey is responsible for the production and maintenance of aeronautical charts and chart related products. The maintenance of visual aeronautical charts is assisted by airborne surveys of charted areas within the United States. These surveys permit current inspection and editing of data portrayed on the charts. This paper describes the theory, development, and use of a Computer Generated Area Navigation (RNAV) Waypoint Grid System for airborne surveys. Control for these surveys is provided by aircraft equipment utilizing the VOR/DME navigation facilities of the National Airspace System. Bearings and distances (waypoints) from existing facilities are fed into RNAV equipment to create the survey grid. These waypoints are generated by a computer program using coordinate search and geodetic computation techniques from a navigation facility data base. The resultant waypoint grid data, in a form easily used in the aircraft's RNAV equipment, provide accurate position and guidance information for the survey. This method may fulfill the control requirements for other airborne surveys.

Fronczek, C. J.

Use of calibration base lines. *NOAA Technical Memorandum NOS NGS 10*, Dec. 1977, 38 p. PB279574

During the early 1970's, the number and types of electronic distance measuring instruments (EDMI) dramatically increased. Their use was expanded to cover almost every conceivable surveying problem. Quality assurance became a pressing concern. But, unlike tape or wire standardization, no recognized agency or organization was responsible for calibration standards for EDM. Therefore, in 1974, the National Geodetic Survey of the of the National Ocean Survey began establishing a series of calibration base lines for this purpose. This publication was prepared in conjunction with this program and is directed to the land surveyor who used EDM. General observing procedures are outlined, and an analysis of the observations is developed. Detailed formulas are given for determining the geometric transformation of distances. An analysis is made of error sources affecting the ambient refractive index.

Gergen, J. G.

New adjustment of the North American Datum--associated computer products. Presented to the *American Society of Civil Engineers Spring Convention*, Dallas, Texas, Apr. 25-29, 1977, 12 p. (LISD)

The horizontal geodetic network of the United States comprises over 220,000 stations, most of which were surveyed in the past 4 decades. Their inclusion in the National Network has gradually strained the accuracy of the 1927 adjustment, which led to the North American 1927 Datum, and has made a new adjustment mandatory. Important topics relating to the New Adjustment (identified as North American Datum 1983) are the selection of a new datum, the effect on the coordinate system, as well as new possibilities for data dissemination resulting from advances in electronic computing.

Gibson, P. N.

Toward a more efficient cartographic style for urban planning maps. *Proceedings of the American Congress on Surveying and Mapping*, Feb.-Mar. 1977 p. 7-21.

The International desire for standardization in measurement and specifications is very strong. For several years, there have been attempts by several cartographers to standardize the symbols used in all areas of cartography. Many accomplishments have been made in the area of standardizing symbols for use with topographic maps. However, in the area of thematic mapping, the accomplishments toward standardization have been comparatively small. More specifically, there have been almost no efforts to link the standardization of symbols with the maps used for urban area planning. The present system, or "style" of mapping used for urban area planning maps is examined. The definition of style for this study was "style is the product of perception." Accepting this definition, a new style for urban area planning maps was devised, incorporating a systemization and standardization of the necessary symbols. This style of mapping was then tested, utilizing the four basic map reading skills (Counting, Locating, Comparing and Verifying). The statistical analysis of the results indicated this new style of mapping is a more efficient and effective method of mapping urban areas for planning purposes.

Goad, C. C.

Application of digital filtering to satellite geodesy. *NOAA Technical Report NOS 71 NGS 6*, May 1977, 73 p. PB270192

Because the Earth is not a rigid homogeneous sphere, the path of a near-Earth satellite will deviate from a perfect ellipse. If accurate measurements of satellite orbits are available, one can hopefully deduce parameters from the observed orbital motions which model geophysical features. This dissertation gives the results and techniques to estimate one nonstationary variation in the Earth's gravity field--the principal lunar semi-diurnal (M_2) ocean tide. Since the ocean tides cause periodic perturbations with periods greater than a week in the evolution of the Keplerian elements of a satellite, the mean Keplerian elements (osculating Keplerian elements less all short period

oscillations) are studied. To date, no investigator has produced mean Keplerian elements accurate enough to observe the small variations caused by the M_2 ocean tides. To solve this problem, approximate analytical transformations have been applied which account for large first-order effects. Elimination of very high frequency effects is accomplished with the aid of an ideal low-pass filter. Precise transformations are only part of the solution, however. Accurate orbits significantly affected by ocean tides must be available. Fortunately, two such satellite orbits were obtained--1967-92A, a U.S. Navy satellite, and the NASA satellite, GEOS-3. Two terms in the harmonic expansion of the M_2 global tide height can be observed. Estimates of these coefficients have been obtained. These estimates are somewhat smaller than recent published values obtained from numerical solutions of Laplace tidal equations. Application of the satellite derived M_2 ocean tide coefficients to the problem of the deceleration of the lunar mean longitude yields an estimate of -27.4 arc seconds/century², which is in close agreement with recent analyses of ancient eclipses and modern transit data. Because the entire tidal deceleration of the lunar mean longitude can be accounted for by the ocean tide model obtained in this study, it can be inferred that the solid tide phase lag must be less than 1° . Knowledge of these important quantities in geophysics and space science, as well as the method developed to extract this information from satellite orbits, are considered important contributions of this study.

Goad, C. C., and Douglas, B. C.

Lunar longitude deceleration and tidal parameters estimated from satellite orbital perturbations. *Proceedings of the 8th International Symposium on Earth Tides*, International Astronautical Federation, Sep. 1977.

Two recent astronomical estimates of the decay in the mean lunar longitude rate are in the range -26 to -30 arc sec/(100 yr)² for \dot{n} (n is lunar mean motion). Lambäck in 1975 discussed this effect in terms of an energy exchange through the solid Earth phase lag and very few harmonics in the expansion of the M_2 , O_1 , and N_2 ocean tides (M_2 contributing about 85%). These same physical features of the solid Earth and oceans also perturb the orbits of near-Earth artificial satellites. New analyses of mean orbital elements of 200 days of GEOS-3 and 160 days of a U.S. Navy navigation satellite have yielded observational equations for the combined solid Earth and M_2 ocean tides. Assuming the solid Earth Love number k_2 to be 0.30 and its phase δ_2 to be 0° , one obtains a value of \dot{n} equal to -26 ± 3 arc sec/(100 yr)². \dot{n} values computed entirely from new numerical ocean tide models by Schwiderski and Estes are -27.5 and -27.6 arc sec/(100 yr)², respectively. Assumption of a solid tide phase lag of 1° or larger yields ocean tide parameter estimates from artificial satellite perturbations inconsistent with the numerical M_2 solutions. Thus, our assumed small solid phase lag is reasonable. The satellite-derived ocean tide values of second degree and order represent an equatorial ocean bulge leading the Moon by 60° . The artificial satellite results are especially satisfying in that no knowledge of tidal mechanisms was required to obtain the results quoted.

Henriksen, S. W.

Systems for the determination of polar motion. *NOAA Technical Report NOS 72 NGS 7*, May 1977, 55 p. PB274698.

The benefit of long-term observations of latitudinal variation is primarily the derivation of corrections to time and astronomical coordinates of control points. Other applications (those with which this report is concerned) include maintenance of an internationally accepted coordinate reference system, monitoring of the Earth's pole of rotation, and studies of the possible relationship of earthquakes to polar motion. Data produced by classical methods, since 1899, are insufficient to permit accurate prediction of polar motion, to determine the amount or existence of secular drift of the pole, or to detect the possible effects of earthquakes on polar motion. For these and other reasons, the international participants in the program agree that the program should be continued for at least another 50 to 100 years and that more accurate observation methods should be developed. The National Ocean Survey's National Geodetic Survey, in its role as the U.S. participant in the program, suggests a number of alternatives for solution of the problems enumerated and for consideration by the international community.

Holdahl, S. R.

Recent elevation change in southern California. *NOAA Technical Memorandum NOS NGS 7*, Feb. 1977, 19 p. PB265940

Velocities of elevation change for two time periods have been determined from southern California leveling data. Two periods were selected for study: 1906 through 1962, and 1959 through 1976. The study area extends from San Pedro north to latitude $35^{\circ}5'$, and between longitudes 117° and $119^{\circ}5'$. The shape of the fitted velocity surface for the latter epoch agrees with the original uplift established by Castle et al. (1976) with the exception that no eastern termination is evidenced within the study area. The velocity surface for the earlier time period shows negligible subsidence of 1 mm/yr at Palmdale, increasing to 9 mm/yr at Bakersfield. The 11 mm/yr maximum uplift velocity determined for the period 1959 through 1976 is approximately twice the corresponding standard deviation. Weighted velocities, extracted from tidal records at six stations on the coast, were used to provide input for absolute height change.

Holdahl, S. R., and Hardy, R. L. (Iowa St. U.)

Solvability and multiquadric analysis as applied to investigations of vertical crustal movements. *Proceedings of the International Association of Geodesy Symposium on Recent Crustal Movements*, July 1977.

A variety of geodetic measurements can be combined to estimate velocities of elevation change. However, in some adjustment models, it is not always apparent which network junctions can yield velocities directly. When coefficients of a velocity surface are desired, it is not always apparent how many can be reliably determined. A test for solvability, devised to operate on

observation equations, answers these questions and, therefore, permits the adjustment process to continue with the assurance that the result is mathematically justified. Using a reciprocal hyperboloid as the quadric form, multiquadric (MQ) analysis has been applied to leveling and tide gage data to simultaneously obtain heights at a selected date, and coefficients which collectively define a velocity surface. Taken individually, the MQ coefficients may be interpreted as indications of rates of density change in the vicinity of point masses. The solvability algorithm has been implemented with MQ analysis to allow automatic location of an optimum number of nodal points (point masses).

Hothem, L. D.

The new adjustment of the North American horizontal datum--Doppler satellite positioning program. *American Congress on Surveying and Mapping Bulletin*, v. 56, p. 17-18.

This is the sixth in a series of articles in the *ACSM Bulletin* on the new adjustment of the North American Datum. The purpose of the series is to inform the surveying community of the progress and problems associated with the massive task of the new adjustment. In support of the new adjustment of the North American horizontal datum, the Doppler satellite positioning method, which employs worldwide geodetic positioning in a common geocentric coordinate system, will be used throughout the North and Central American region. The National Geodetic Survey (NGS) of the National Ocean Survey has completed a primary network of 150 Doppler stations in the conterminous United States. One hundred additional stations are being established by NGS in Alaska, Hawaii, and Puerto Rico. These stations are spaced at intervals of 50-300 km and will provide additional scale and orientation to the new adjustment.

Hothem, L. D., and Strange, W. E.

Doppler satellite positioning of offshore structures. *International Hydrographic Review*, v. 54, p. 39-58.

Both for reasons of accuracy of results and economy of operation, Doppler satellite positioning has become an important technique for extending geodetic control surveys into the offshore areas. Fixed-site Doppler satellite surveys to position offshore structures have been reported in areas of the Canadian coastal waters, North Sea and Gulf of Mexico. The navigation or two-dimensional positioning mode and the more accurate three-dimensional positioning mode are the basic Doppler satellite positioning techniques. The Doppler station accuracy is a function of the orbital data accuracy and the method of data reduction. Provided site conditions are met and equipment operation is normal, the accuracy of Doppler satellite positioning of offshore structures is estimated to be 0.5-1.5 meters rms in each coordinate. In order to make use of the accuracy inherent in Doppler positioning, care must be taken in relating the positions to the local datum coordinate system.

Hothem, L. D., Strange, W. E., and White, M. B.

The Doppler satellite surveying system. Presented to the *American Society of Civil Engineers Annual Convention*, San Francisco, Calif., Oct. 17-21, 1977, 22 p. (LISD)

The National Ocean Survey's National Geodetic Survey has utilized the Doppler satellite surveying system since 1972 to establish geodetic control at about 200-km station spacing in support of the new North American horizontal datum adjustment. Relative positional accuracies of better than 1 m were obtained using 40 passes of data. With improved tracking instrumentation and field operating procedures and refinements in the data reduction programs, positional rms errors are not less than 50 cm for 40 pass solutions. RMS errors of ± 10 cm for differential positions for latitude and height are now possible using 150-200 passes in a solution. Because of its portability, all-weather capabilities, low cost, and accuracy, the Doppler satellite technique of positioning is increasingly being used by surveyors around the world to meet control requirements for surveying and mapping at remote locations such as offshore structures, islands, wilderness areas, and other areas where existing control is sparse. While studies are continuing to determine the limited accuracy of the present Doppler system, improved Doppler satellite surveying using the Global Positioning System (GSP) is being researched. Preliminary studies indicate this system may be more practical and cost effective in meeting the needs of the worldwide surveying community by giving better than 10-cm accuracy with observation time of 1 day or less. Ten-centimeter accuracy represents better than 1 part in 35,000 for 5-km station spacing.

Hull, W. V.

The use of tidal datums in coastal problems. Presented to the *American Shore and Beach Preservation Association Annual Meeting*, Washington, D.C., Oct. 17-19, 1977, 6 p. (LISD)

Tidal Datums comprise the fundamental reference from which all coastal and marine boundaries are derived. Their fundamental nature is based on historical precedence, judicial doctrine, and definition-based computational procedures. In fulfilling one of its statutory obligations, the National Ocean Survey provides tidal datums to all private, State and Federal interests without interference in the responsibilities or prerogatives of any person, organization, or governmental unit. The National Ocean Survey Federal-State Marine Boundary Program extends the datum to coastal and marine boundary delineation in a fully cooperative plan. It has been demonstrated that this program is not only mutually beneficial to all parties concerned, but extremely efficient at a time of high costs and major resource demand.

Isner, J. F.

The new adjustment of the North American horizontal datum--block validation and data entry. *American Congress on Surveying and Mapping Bulletin*, v. 58, p. 17 & 19.

The new adjustment of the North American Datum is comprised of a collection of interrelated tasks. Data capture and validation at the individual project or field survey level make up the first and most critical task. About 200 staff-years will be required to put 5,000 archival projects into computer-readable form. Each project is then subjected to a complex procedure culminating in the adjustment by least squares and statistical analysis of all observations contained within the project. Between the validation of individual projects and the actual network adjustment are two important tasks: Block validation is concerned with a higher level validation at the inter-project level to insure a good fit and spot voids in missing data. The other task, data entry, involves the construction of the national network from its parts and merging all other data types which will influence the adjustment results.

Keller, M.

A study of applied photobathymetry in the National Ocean Survey. *Proceedings of the American Society of Photogrammetry*, Oct. 1977, p. 76-85.

Classical hydrographic mapping in shallow waters with surface craft is slow, hazardous, and expensive. The remarkable water penetration capability of several currently used film emulsions and their dramatic presentation of submerged detail provides an alternative tool and supplement for mapping the seabed in shoals and water of moderate depth. Photogrammetric-bathymetric surveys preceding hydrography can show many of the rocks, reefs, shallow areas, photogrammetrically observed depth measurements and depth curves, and other features, and thereby assist the hydrographers whose work is more difficult because they do not have the overall view of the bottom to guide their operations in developing important details. This paper examines photogrammetric bathymetry's potential for: (1) improving the accuracy and completeness of the hydrographic survey; (2) reducing the cost and time of the field hydrographic survey; and (3) reducing ship requirements for a particular hydrographic survey, thereby releasing some of the craft for other assignments and/or enlarging the size of the coastal water areas that can be surveyed within a given time frame. The investigation potential was restricted to 10 regions of high priority along the U.S. east coast and the Gulf of Mexico. A 5-year photobathymetry program is envisaged that will require a maximum of 10,765 man-days of work and cost \$1,154,750. These figures can be substantially reduced by employing digitized stereoscopic plotting instruments and developing advanced, sophisticated photogrammetric analytic aerotriangulation procedures.

Kumar, M., and Mueller, I. I. (Ohio St. U.)

Detection of crustal motion using spaceborne laser systems. Presented to the *International Association of Geodesy Symposium on Recent Crustal Movements*, Palo Alto, Calif., July 25-30, 1977, 21 p. (LISD)

The spaceborne laser ranging (or laser) system provides a method of precise positioning of a large number of points on the Earth's surface in a

short period of time. That is, a measure of the relative location of geodetic markers from a space platform can maintain horizontal and vertical control to 2-5 cm. At this level of control, small Earth surface crustal motions should be detectable. Development of a model for the strain field can be constructed. Furthermore, the spaceborne lasering system can survey an area in a very short period of time (1-2 weeks) and resurvey the area as required. System design parameters are now being established by NASA for a possible test flight aboard the Shuttle in 1982. These include design specifications of economical corner cubes for ground retroreflectors coupled with the evolution of engineering model to flight model development. If the experiment of the Shuttle proves to be successful, it is hoped to put the laser in a free flight satellite. This paper presents the results of a simulated analysis for this latter case. The system is conceived as an orbiting ranging device with a ground base grid of reflectors or transponders (spacing 1.0-30 km), which are projected to be of low cost (maintenance-free and unattended) and which will permit the saturation of a local area to obtain data useful to monitor crustal movements. The test network includes 75 stations with roughly half of them on either side of the San Andreas fault zone. Critical study comparatively evaluates various observational schemes and statistically analyzes crustal motion recovery. The study considers laser radar as the main ranging system pending final selection from many possible candidates. The satellite orbit is inclined at 110° and slightly eccentric ($e = 0.04$) with orbital altitudes varying from 370-930 km. The results indicate that the geometric mode (simultaneous ranging) with a minimum of five grid and three distant (fundamental) stations and mixed ranging to satellite and airplane seems to be most promising. The fundamental stations are distinguished from the grid station in their location and this location should be "distant" enough from the area of crustal movement so that they can be considered stationary over the time span of the motion involved. The recovery of motion rate for magnitude is quite straightforward, while for direction each case may require consideration on its own merit. The study also recognized the sensitivity of the results/deductions obtained thereof to any design of experiment associated with them. For the specified setup, time interval between two sets of station recovery for different motion rate or ranging accuracies has also been suggested.

Martin, D. M., and Earle, M. D.

Hydrographic applications of offshore tide measurements. Presented to the *XV International Congress of Surveyors*, Federation Internationale des Geometres, Stockholm, Sweden, June 1977, 17 p. (LISD)

The preparation of offshore nautical charts requires the determination of offshore tides in order to reduce soundings to specified chart datums. Until recently, however, tide measurements could only be operationally made at coastal locations, thus requiring that offshore tidal height corrections be extrapolated from coastal tide measurements. Extrapolation procedures generally used the velocity of a shallow water wave to obtain times of offshore tides, and offshore tidal heights were assumed to be the same as at nearby coastal locations or were estimated based on the general knowledge that the tidal range usually decreases offshore. These methods often resulted in poor offshore tidal height values which in turn caused apparent discrepancies at the inter-

sections of sounding lines and crosslines. Discrepancies between present and past hydrographic surveys and between geographically adjacent surveys have also been attributed to poor tidal height corrections. In addition, more accurate offshore tide information is required as deep draft vessels traverse offshore areas whose depths, in the past, were not considered hazards to navigation. The purpose of the National Ocean Survey offshore tide program is to collect offshore tide data for the reduction of offshore soundings for nautical charting and for the development and verification of models to compute tidal characteristics over continental shelves. Two types of measurement systems are presently in use. Deep-sea tide gages make measurements over continental slopes and the deep ocean, and real-time telemetering tide gages monitor tides over continental shelves during hydrographic surveys. Deep-sea tide gages were successfully used during hydrographic surveys off the southeastern coast of the United States and in New York Bight. Real-time telemetering tide gages were also successfully used during the New York Bight hydrographic survey. An important result of the offshore tide measurements is the preliminary verification of the Defant method as a simple method for the practical computation of offshore tides to support hydrographic surveys. The offshore tide program is continuing the operational monitoring of offshore tides during hydrographic surveys and the development of better tidal models for the reduction of offshore soundings when offshore tide measurements are not available.

Mero, T. N., and Appell, G. F.

Marine dynamics and its effects on current transducers. *Flow Measurement in Open Channels and Closed Conduits*, National Bureau of Standards special publication #484, v. 1, p. 109-122.

A growing interest in measuring current velocities in the coastal zone and estuaries prompted the creation of a Dynamic Analysis Program at the National Ocean Survey's Test and Evaluation Laboratory. The dynamics of near-shore current flows are more severe than that of the deep ocean. Therefore, it is important to qualify the performance of current measuring transducers in a dynamic environment. A study was contracted to determine what scales and intensities of turbulence exist in the near-shore environment. The major effort of the study is concerned with turbulence from 1-20 Hz and scales up to 30 cm. Tests are being conducted to determine the response characteristics of several current measuring transducers, including both rotor and electromagnetic instruments. These tests include grid-produced turbulence measurements as well as simulated tests of mooring-line dynamics. Measurements have revealed several transducers that have 10-20% sensitivity increases when turbulence intensities of 6-12% are present. Turbulence that exists in the marine environment and dynamic response characteristics of several current measuring transducers are described.

Mitchell, G. J.

National Geodetic Survey contribution to modern land data systems. Presented to the *American Congress on Surveying and Mapping Annual Meeting*, Washington, D.C., Feb.-Mar. 1977, 7 p. (LISD)

We live in a turbulent society--in a world in which uncertainty is the norm. Attempts to become a planning society are frustrated by the lack of basic information in useable form. Although the use of computers and other technological developments have moved us toward useful information systems, their use is sporadic and fragmentary. The land on this planet can be measured, categorized, and identified uniquely. The National Ocean Survey's National Geodetic Survey (NGS) supports the development of coordinate-based modern land data systems. NGS contributions and planned future supportive activities, such as technology exchange, will be discussed.

Mobley, W. L.

Bathymetric Swath Survey System and its potential for effective bottom mapping. *Proceedings of the U.S. Army Corps of Engineers Hydrographic Survey Conference*, Nov. 1977.

National needs require improvement in present survey systems and techniques for acquiring and processing bathymetric data. Requirements for such data include their use in support of changing navigational uses in nautical and engineering projects. The objectives of the Bathymetric Swath Survey System (BS³) Program are to improve the effectiveness of marine surveying, improve data quality, and to provide useful engineering data for nautical charts and bathymetric maps. BS³ operations can be divided into three areas: (1) U.S. west coast and Alaska--shallow water operation; (2) U.S. east coast, Gulf of Mexico, and Great Lakes--shallow water operations; and (3) deep ocean operations. The development of new instrumentation and operational techniques for shallow water operations along the U.S. west coast and Alaska is underway with the procurement of a modified General Instruments 21-beam "BO'SUN" sonar, which will be installed aboard the NOAA Ship DAVIDSON. The surveying and processing techniques, aimed at improving the effectiveness of bottom mapping, will be demonstrated this spring in Puget Sound near Seattle, Washington.

Morrison, F. F.

Azimuth-dependent statistics for interpolating geodetic data. *Bulletin Geodesique*, v. 51, no. N^o, 2, p. 105-122.

Most authors using statistical interpolation techniques on geodetic data have assumed isotropy for the undulation autocorrelation. Tests of actual data, 414 deflections of the vertical, indicate this assumption is not valid. The results of interpolation, however, are not very sensitive to the parameters in the covariance function. A special limiting case for which statistical interpolation degenerates into a completely deterministic process is given in the spherical domain. In this case the covariance function has absolutely no effect on the results, so that the covariance of the output of a prediction need not be that assumed for the interpolation. This provides a self-correcting process whereby the information in the data corrects for a poor choice of covariance function. Estimates of the precision of the interpolation, on the other hand, are very sensitive to the covariance function,

particularly to the modeling of azimuth dependence. A simple procedure for generalizing isotropic functions to azimuth dependence is given, which provides sufficiently accurate estimates of precision. The advisability of trend removal is illustrated by some numerical examples.

Munson, R. C.

Positioning systems--report on the work of WG414b. Presented to the *XV International Congress of Surveyors*, Federation Internationale des Geometres, Stockholm, Sweden, June 1977, 33 p. (LISD)

Positioning systems which have potential application to hydrography are examined on the basis of a survey of worldwide hydrographic system users and manufacturers. Only electromagnetic distance measuring (EDM) systems are currently in general use for providing the necessary accuracy for inshore surveys with 1σ position accuracy levels of approximately 10 m for survey scales of 1:10,000 and 5m for survey scales of 1:5,000. Two different types of EDM systems are currently in use--short range systems generally using microwave ranging from a mobile transmitter to a pair of shore based transponders, and medium range systems most commonly using three or more shore based transmitters at ~2 MHz and any number of passive receivers. Several variations of each type of system have been developed in attempts to alleviate one or more of the problems encountered in actual system operation. In the test results reported from a survey of worldwide national hydrographic agencies and equipment manufacturers, only the short range systems demonstrated the 10m positioning accuracy. Several of the more expensive short range systems also demonstrated the capability of producing 5 m positioning accuracy. Such systems were found to be used generally as reference systems for calibrating and testing other systems. Positioning accuracy levels demonstrated for the medium range systems were on the order of 20m. Test results were, however, available for only a limited number of the systems now in operation around the world, although most systems use approximately the same operating frequencies and would encounter similar propagation and other operational problems. Positioning systems expected in the future include the Global Positioning System from which 10 m position accuracies on an absolute basis are forecast, with the prospect of somewhat higher accuracies on a relative basis.

National Ocean Survey

Baseline report of environmental conditions in Deepwater Dumpsite 106. *NOAA-NOS Technical Service Publication*, June 1977, 3 v., 798 p. PB272577 (v. 1-PB272578; v. 2-PB272579; v. 3-PB272580)

Public Law 92-532, the Marine Protection, Research, and Sanctuaries Act of 1972, put an end to the unregulated disposal of wastes in offshore waters of the United States. The National Oceanic and Atmospheric Administration (NOAA) has the responsibility under Title II of the Act to conduct monitoring and research to determine the environmental effects of the dumping of waste materials into ocean waters. This baseline report contains the results of field studies conducted by NOAA in and about the Deepwater Dumpsite 106 (DWD-106), approxi-

mately 106 nautical miles from Ambrose Lightship and 90 nautical miles due east of Cape Henlopen, Delaware, for the purpose of characterizing the site's environment and biota. The studies were conducted in May 1974, July 1975, and February 1976 on the ships ALBATROSS IV and DELAWARE II, ALBATROSS IV and the submersible ALVIN, and OREGON II, respectively. A variety of wastes are disposed in DWD-106, but efforts were concentrated on American Cyanimid and duPont wastes since these constituted about 80 percent of the total volume of material entering the area. One objective of the DWD-106 studies has been to characterize baseline conditions in the region in its present status as a receiving area for industrial wastes. Obtaining a pure pre-dumping baseline has not been possible since systematic quantitative measurements were not taken before dumping began. The Baseline Report is divided into three sections: Physical Characteristics, which appear as volume 1; Biological Characteristics, volume 2; and Contaminant Inputs and Chemical Characteristics, volume 3. An appendix, containing details of data, is included in volume 3. Characterization results are chiefly from three baseline cruises, but also from data obtained during two summer 1976 experimental cruises, as well as from National Marine Fisheries Service sources. While emphasis has been on site characterization, inferences as to the effects has been on site characterization, inferences as to the effects of dumping have been made where appropriate.

National Ocean Survey

National Geodetic Survey publications on surveying and mapping. *NOAA Technical Memorandum* NOS NGS 9, Sep. 1977, 17 p. PB275181

Current lists of geodetic publications and information published by the National Ocean Survey's National Geodetic Survey, along with sources of availability, are cited.

Parker, B. B.

Tidal hydrodynamics in the Strait of Juan de Fuca-Strait of Georgia. *NOAA Technical Memorandum* NOS 69, Jan. 1977, 56 p. PB270191

The results of the harmonic analysis of data from 95 tide stations and 90 current stations in the Strait of Juan de Fuca-Strait of Georgia system are presented in the form of tables, cotidal and corange charts, and charts illustrating the relationships between various tidal constituents. The implications of these results relative to the tidal hydrodynamics of the system, are discussed, and methods of analysis are described. A physical description of the area is also given along with approximate values of transport through key cross sections.

Polanin, B. P., New, R., and Ringenbach, M. E.

How good are your marine data? Presented to *Oceans '77*, International Electrical and Electronics Engineers-Marine Technology Society, Los Angeles, Calif., Oct. 17-19, 1977, 29 p. (LISD)

The National Ocean Survey, NOAA, has a deep concern over assuring the quality of the data acquired in various marine measurement programs which are being reported in various scientific journals and reports, and especially data which are being archived in data banks. The motivating factor in NOAA's efforts in data quality assurance is that, while a significant problem probably does exist, to the best of our knowledge the extent of the problem and its impacts have never been investigated and reported in any significant depth. In this context, data quality refers to a statement associated with all reported data which includes some valid measure of uncertainty. Our subjective is that a large group of users use the data, gathered from various sources, uncritically, assuming that the data are "good" which may or may not be true; other potential users are hesitant to use the data because of uncertain data and hence take expensive steps to acquire additional data to meet their requirements. A valid statement of uncertainty or error-bounding of the data should eliminate users doubts and allow for knowledgeable decisions regarding changes in the marine environment. Data quality assurance activities are being established in measurement programs where the data will be used for law enforcement or judicial purposes; however, much more progress must be made in this area. It is the intent of NOAA's data quality assurance program to present a series of papers (hopefully one at each annual International Conference and Exposition) to describe the program results from year to year. Our initial effort, presented in this paper, is directed toward: (1) the assessment of the problem; (2) a more precise definition of the phrase "data quality assurance," since the problem starts with the lack of a common agreement on its definition; (3) an investigation of marine data quality reporting using various sources (Oceans '77 Proceedings, referred journals, other journals and reports, and data banks); and (4) a statistical analysis (designed in a manner to assure no bias) of the data quality reporting to provide a quantitative estimate of the problem if it exists and to highlight those categories which are grossly deficient in reporting data quality. The results and evaluation of this first phase of analysis are presented along with NOAA's plan for following phases.

Schemery, L. W.

Copperplate engraving (nautical charts). Presented to the *XIII Pan American Consultation of Cartography*, Pan American Institute of Geography and History, Quito, Ecuador, Aug. 15-31, 3 p. (LISD)

Copperplate engraving, as a means of reproducing nautical navigational charts, was first used in the United States in the early 1830's. The Coast and Geodetic Survey, now the National Ocean Survey, recognized as the Nation's first Federal chart maker, was established in 1807 and employed copperplate engravers for chart engraving from the 1830's into the early 1940's, spanning a period of over 100 years. During the 100-year period that the Coast and Geodetic Survey was engaged in the copperplate engraving art, this function, as applied to chart production, attained a level of artistry in the agency that was unexcelled in the world. An overview of this 100-year period of copperplate engraving in the Coast and Geodetic Survey is presented.

Schwarz, C. R.

The geodetic data management system at the National Geodetic Survey.
Proceedings of the International Symposium on Optimization of Design and Computation of Control Networks, International Association of Geodesy, July 1977.

The National Ocean Survey's National Geodetic Survey (NGS) is responsible for the observation, adjustment, and publication of the national geodetic network. Technological progress of the last 50 years demands more precise geodetic control than can be obtained from the North American 1927 Datum. Recognizing the needs of industry, science, and government, the National Academy of Sciences recommended the redefinition of the North American Datum which would satisfy contemporary needs. As part of the ongoing readjustment program, the NGS is in the process of preparing all of its horizontal observation and publication data for automated data processing. The storage, editing, updating, and retrieval of the huge volume of data will be handled by a geodetic data management system and will thus play a critical role in the readjustment of the new North American Datum.

Slama, C. C.

Application of photogrammetric analytical triangulation to geodesy. Presented to the *American Congress on Surveying and Mapping-American Society of Photogrammetry Annual Meeting*, Washington, D.C., Feb.2-Mar. 3, 1977, 11 p. (LISD)

In 1974 the National Ocean Survey began an investigation of methods for high precision analytical photogrammetry. The basic goal of the study is to develop instrumentation, procedures, and data reduction techniques which will lead to an optimum system whereby the densification of high order geodetic ground positions can be established with quick response and cost-effective use of analytical photogrammetry. The system concentrates on the control of systematic error through the employment of a special geodetic reseau lens cone, sophisticated mensuration, special flight geometry, and special targeted ground points. Initial data reduction of test materials flown over a controlled test field have shown that the system will produce ground coordinates with the predicted precision. That is, it is predicted that the resulting standard error of each horizontal coordinate should be no greater than 5cm using photography flown at an altitude of 12,000 ft.

Slama, C. C.

Computer aided photobathymetry. *Proceedings of the American Society of Photogrammetry*, Oct. 1977, p. 88-105.

Photogrammetric compilation of bathymetric detail at the National Ocean Survey (NOS) is accomplished stereoscopically from overlapping pairs of photographs using analog plotting instruments. Present methods require a graphic correction for the deformation of the stereoscopic model introduced by refraction at the water-air interface. The correction factor by which the apparent depth must be multiplied is a variable whose magnitude depends on

the apparent water depth, the index of refraction, and the location of the submerged feature in the stereoscopic model. NOS has recently acquired a Wild B-8S Aviograph stereoplotter, interfaced with digital output. The cumbersome graphical correction routines currently employed will be replaced by computer programs that will mathematically compensate for model deformation and the effect of refraction at the water-air interface. It is expected that the successful implementation of this partial automation effort will ultimately lead to a fully automatic solution employing analytical stereoplotters.

Slama, C. C.

Densification of geodetic control using highly precise photogrammetric triangulation. Presented to the *XIII Pan American Consultation on Cartography*, Pan American Institute of Geography and History, Quito, Ecuador, Aug. 15-31, 1977, 4 p. (LISD)

A method is described whereby numerical photogrammetric triangulation is used to establish monumented ground positions with geodetic accuracies. The procedure employs a special geodetic camera lens cone equipped with a reseau in the focal plane to photograph special ground targets. System errors are reduced by using a highly precise stellar calibration of the camera's internal geometry, along with flight coverage that provides optimum geometry for intersection. Computer programs are being developed to incorporate highly sophisticated statistical reduction techniques for all phases of data handling. The method will have applications for the densification of present geodetic nets in highly developed urban areas.

Smith, R. A.

Golden Gate tidal series one century plus. Presented to the *American Geophysical Union Fall Meeting*, San Francisco, Calif., Dec. 4-8, 1977, 17 p. (LISD)

The longest continuous uninterrupted tidal series in the United States began in the Fort Point area of the Golden Gate in California on June 30, 1854. Recordings of the tide observations for this tidal series are continuing today at the Presidio, San Francisco. There is a slow, secular change in the relation of land and sea over the duration of the tidal series. The summarization of the various tidal datums and range of tide over the years indicates variations that occur over short- and long-term periods of time. These variations cause re-evaluation of the tidal datums on a continuing basis. Such changes may be sufficient to warrant a closer look at boundary determination between sea and shore and in mapping the coastline. The characteristics of the entire tidal regime of the long-term primary tidal series in the Golden Gate area have resulted in a better understanding of the criteria essential in establishing tidal datums. The National Ocean Survey has developed the operation of a network of primary tide stations where continuous records of the rise and fall of the tide are obtained for the determination of tidal datums, used for mapping, surveying and other engineering purposes.

Spencer, J. F.

The National Geodetic Data Center: today and tomorrow. *Proceedings of the American Congress on Surveying and Mapping*, Oct. 1977, p. 428-433.

The mission of today's center is to maintain, publish, and distribute geodetic control data. During the presentation an informational flow diagram will be used as an aid. Tomorrow's center will carry on the same basic mission with the following changes: (1) a phenomenal increase in the size of the geodetic data file will take place; (2) the conversion and digitization of the data file and its restructure into a data base will be accomplished; and (3) the improvement of data products and services through the utilization of automated publication and distribution techniques will occur. These changes are discussed.

Spencer, J. F.

The needs and requirements for a national geodetic data center. *Proceedings of the Second Federal Coordinating Conference*, U.S. Geological Survey, Jan. 1977, p. 37-44.

The need and requirements for a proposed National geodetic data center are discussed, as well as the present status of the plan formulated by the National Oceanic and Atmospheric Administration. The center would provide a central depository for Federal geodetic data compiled for the 50 United States. This information would be available for dissemination upon request to other Governmental agencies, State and local governments, and the public.

Sprenke, J. J.

Precision conductivity measurements. *Ocean Systems Conference Proceedings*, Plessey Environmental Systems, San Diego, Calif., Jan. 1977, p. 135-142.

For the last few years the National Ocean Survey's Test and Evaluation Laboratory has been making precision salinity measurements using the Precision Conductivity Comparator (PCC). The PCC, originally a Precision Salinometer and Test Facility (Model 6340) built by Bissett-Berman in the mid-to-late sixties, was modified in both principle of operation and design. This paper describes the PCC and some of the measurements that have been made using it. For example, a comparison of some standard seawater batches was made to determine variability among them, and the temperature coefficient of standard seawater was measured and compared to existing equations.

Strange, W. E., and Fury, R. J.

Computations of deflections of the vertical in support of the readjustment. *Proceedings of the International Symposium on Optimization of Design and Computation of Control Networks*, International Association of Geodesy, July 1977.

The National Ocean Survey's National Geodetic Survey, in cooperation with appropriate agencies of other nations on the North American continent, is carrying out a readjustment of the North American horizontal control network. Within the United States, there are approximately 200,000 geodetic control points, but only about 5,000 astronomic positions. For highest accuracy in reduction of the horizontal angles, deflections of the vertical with an accuracy of 1 arc second or better are desired at all control points. To accomplish this, a method for rapid computation of gravimetric deflections has been developed. The procedure will use numerical integration and surface gravity in the near area and satellite harmonic coefficient data in the distant area. Terrain corrected surface gravity will be used in mountainous areas to approximate the first-order Molodensky correction. Existing astronomic deflections, Doppler satellite positions, and results from other space techniques will be used to assure the elimination of systematic error.

Strange, W. E., and Pettey, J. E.

The new adjustment of the North American horizontal datum--geodetic astronomy. *American Congress on Surveying and Mapping Bulletin*, v. 57, p. 19 & 44.

This is the seventh in a series of articles in the *ACSM Bulletin* on the new adjustment of the North American Datum (NAD). The purpose of the series is to inform the surveying community of the progress and problems associated with the massive task of the new adjustment. Astronomic data for approximately 5,000 stations, observed over a 130-year period, and astronomic azimuths of surveyed lines will be used to provide orientation of the horizontal network on the Earth's surface. Astronomic latitude and longitude measurements will be used with other geodetic data to establish the correct coordinate system to which the new NAD will be referenced.

Whalen, C. T., and Balazs, E. I.

Test results of first order class III leveling. *Surveying and Mapping*, v. 37, no. 1, p. 45-58.

The National Ocean Survey's National Geodetic Survey has programmed for a partial releveing of the first-order, national vertical control net and for readjustment of the entire first- and second-order net during 1977 through 1985. In the past, first-order, class I or II, double-run leveling was used exclusively to establish and releve the first-order net. Programmed funds permit releveing and replacing destroyed marks on approximately half of the national first-order net by double-run leveling, or on essentially the entire net by new first-order, class III, single-run leveling. The new specifications, based on an analysis of leveling errors, were field-tested on a level line from Waldorf to Baltimore, Md., between December 1975 and April 1976. Test results indicate that first-order, class III leveling can provide a viable alternative to first-order, class I leveling for releveing the first-order, national vertical control net.

Yeager, J. A.

Delimitation of the Fishery Conservation Zone on nautical charts of the National Ocean Survey. Presented to the *Canada-U.S. Mapping and Charting Committee Meeting*, Ottawa, Ontario, Canada, June 13-17, 1977, 6 p. (LISD)

The 200-nmi Fishery Conservation Zone was determined by using baseline points selected from small scale NOS charts. These points, which were also used to construct the Territorial Sea and Contiguous Zone were precisely defined by using large scale charts. Geodetic computations were used to produce 200-nmi arcs at 30-minute intervals between given azimuths. The arcs were plotted at a selected scale, and overlapping points were removed manually. The final plot is a smooth curve through the computed points.

Young, G. M.

Status of the new adjustment of the North American horizontal datum. *Proceedings of the Symposium on Regional Geodetic Networks for the Year 2000*, Institute Teknologi Bandung, Indonesia, Nov. 1977, p. 1-14.

The National Ocean Survey's National Geodetic Survey (NGS) is presently involved in a massive effort in support of the new adjustment of the North American horizontal datum. The adjustment will involve 5,000 horizontal control projects containing some 2.25 million observations. It will utilize the Helmert Blocking technique to yield results that will be equivalent to that of a single, simultaneous least-squares adjustment of the entire network. To date, approximately 40 percent of the horizontal control projects have been converted to computer readable form and processed through the preliminary validation phase. Other ongoing projects in support of the New Adjustment include the development and implementation of the final quality control procedure (block validation), the NGS Data Base Management System, and final adjustment computer software. Network strengthening will result from including the recently completed high-precision transcontinental traverse, Doppler satellite positions, and new base lines and Laplace azimuths. The new adjustment, which is scheduled for completion in 1983, will provide improved positions for the more than 225,000 points in the U.S. Horizontal Control Network.